CIE independent review report on the 2011 STAR --- Pacific Hake/whiting Stock Assessment

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Prepared for

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Executive Summary

The 2011 assessments of Pacific hake/whiting (*Merluccius productus*)) stock were reviewed by a Joint Canada-U.S. Pacific hake / whiting Stock Assessment Review (STAR) Panel. The STAR Panel met at Hotel Deca, Seattle, Washington from Feb 7 - 11, 2011. The assessments of the stock done by the Joint Canada-US stock assessment team (STAT) were presented to the STAR Panel and the validity of the data, assessment procedures, and results were discussed. The Panel operated under the U.S. Pacific Fishery Management Council's Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012 (PFMC 2010).

Two proposed age-structured stock assessment methods for Pacific hake, as well as new investigations on the acoustic survey data have been suggested. The two proposed age-structured models were TINSS (Martell et al. 2008) and Stock Synthesis (SS, implemented in Stock Synthesis 3 toolbox package). Because of a coding error in TINSS, the results in the draft stock assessment report distributed to the STAR panel before the meeting was updated through presentations and documents during the review. In addition, the STAR panel requested a summary table on the structure of the models, the types of uncertainties considered in the models, the parameterization of submodels, such as selectivity, maturity, length-at-age and recruitment, and also the priors used in the models. Extra discussions on the uncertainty of the 2008 cohort were held, emphasized by both modelling teams and discussion among attendees. The STAR Panel chair Dr. Tom Jagielo led the STAR Panel report and communicated the report with the joint-STAT panel, the STAR Advisory Panel and other attendees to avoid possible confusion. STAR Panel Members then prepared their individual reviews.

The stock assessments were conducted using TINSS and SS. The last review on Pacific Hake recommended TINSS be used as the stock assessment model because it employed a full Bayesian analysis and the results provided were probabilistic and ready for decision making purposes. SS employed a full Bayesian analysis this year also, which implied that both models should be considered. During the STAR review, the TINSS was modified and after re-parameterizing the selectivity and not binning the age-composition data, the results from the two models were more consistent. Because of the time limitation and the confidence of the STAT team in their prior application, no further exploration of their parameterization and prior assumptions were requested or explored.

The SS working group led by Dr. Ian Stewart investigated several new scenarios: disaggregate the catch data by fishery sectors and by season, consider ageing error, and consider the temporal variation of growth pattern. These investigations are very valuable, though many of them were not used in the final selected benchmark model and were not fully discussed because of the similarity of the results with the preferred base SS model scenario. Ageing error was explored and incorporated in the base SS scenario although the results were not that different from the scenario that did not consider ageing error. Whether a time-varying

selectivity would change the model results was also explored by the SS team. Agreement of the modelling results with the base scenario was examined and was used as the criterion as to whether the scenarios/models were worth being considered by the SS team. Future study on model selection and uncertainty evaluation is suggested.

The TINSS working group led by Dr. Robyn Forrest developed a "new" model over the last year. It used a multivariate logistic distribution instead of multinomial distribution (used by SS3 and widely used in fisheries stock assessment) to model the distribution of age-composition; it also used a binning approach to deal with the low observation and zero values in age-composition observations. The advantages of using multivariate logistic distribution were documented in Richards and Schnute (1998) and in the pre-STAR draft report (JHTWG 2011). One concern of the STAR panel is that the weighting of the age-composition data is equal, i.e., the sample size is not considered in the current TINSS model. Dr. Steve Martell and Dr. Robyn Forrest would like to explore the possibility of adding the effect of the sample size in the future. The advantage of the binning approach is that zero and low proportion values in age composition data can be binned to a neighbouring length or age interval; however, it has the disadvantages of hiding cohort signals. Dealing with zero values in the catch rate or in the age/length compositions has been a problem. The binning approach provided an extra possible approach that should to be considered in the future.

The joint U.S.-Canada STAT stock assessment is considered to be the best scientific information and adequate for evaluating stock status. There are still differences in both biomass estimation and biological reference points (BRP; here, F_{msy}, MSY, $F_{40\%}$) estimates. The interpretation of the hake fishery status and population status are different also. However, the differences are not very big and the time was limited to further explore the driving factors of the differences and whether these factors should be kept in the model as they are. Uncertainty estimation of the parameters, population size, and biological reference points based on fully developed Bayesian analysis should be continued. Full exploration of the influence of the priors and different parameterization in both models and in miscellaneous scenarios was suggested and compared between the two models. It is important to identify which differences should be kept.

Some key recommendations are summarized below:

- Investigate the application of using multivariate logistic distribution in modelling the distribution of age/length frequency. Consider incorporation of sample size in the weighting of the age/length composition data or in the likelihood function of the multivariate logistic distribution.

- Systematically investigate the influence of the priors and parameterization on natural mortality, selectivity, population age structure at the starting of the fishery (1966, the initial year in the models), and the recruitment function;

determine the reasons for the differences in the results (current B, current F, BRPs and ABC given the control rule used for Pacific hake) between TINSS and SS.

- A comprehensive model selection framework needs to be considered, developed and used for the future of the joint STAT assessment. Quantitative model selection criteria and model checking criteria should also be considered.

- More detailed model equation and description of the symbols used in the equations, the submodels used in different scenarios, and the priors used should be provided in future reports.

- Investigate the nonstationarity of the spatial distribution of Pacific hake based on the acoustic survey data.

- Investigate the pattern and/or driving factors of recruitment dynamics of the hake population.

- Investigate the pattern and/or driving factors of the spatial distribution of the hake population.

- The current decision tables provided spawning biomass, depletion and spawning potential ratio given different catch levels and $F_{40\%}$ and F_{msy} levels. Uncertainty of the 2008 cohort was addressed but others were not presented in the current decision table. Risks shown as probabilities of overfishing and being overfished given different catch levels should be provided in the future stock assessment.

1. BACKGROUND

This report reviews the 2011 stock assessments of Pacific hake (whiting, *Merluccius productus*) off the west coast of the U.S. and Canada at the request of the Center for Independent Experts. I was provided with draft stock assessment reports and web access to relevant files and documents (Appendix 1) and participated in the Stock Assessment Review (STAR) Meeting.

The Pacific hake stock assessment will provide the basis for the management of the largest groundfish fishery off the West Coast of the U.S. and British Columbia. In 2009, the Pacific whiting fishery accounted for 79% of the landed catch in the U.S. groundfish fishery. In addition, the treaty between the U.S. and Canada that establishes an annual assessment and management process is expected to be ratified sometime soon.

Two competing models, TINSS and SS, were used in the 2010 pacific hake stock assessment and the differences of the estimated biomass, biological reference points, and fishery and population status of the two models were very large (JHTWG 2011). The draft pre-STAR stock assessment report distributed to the STAR panel indicated that the differences of the results from the two models were still very high (e.g., Catch of 2011 at $F_{40\%}$ = 718,502 from SS, and = 131,000 from TINSS). Model selection uncertainty between the two competing models seemed high for this stock assessment (JHTWG 2011).

2. REVIEW ACTIVITIES

The STAR Panel meeting was held at the Continental Conference Room - Hotel Deca, Seattle, Washington, from Feb 7-11, 2011. The meeting followed the "tentative agenda" of the STAR review. The meeting was open and was attended by observers including members of the fishing industry.

About two weeks before the meeting, assessment documents and supporting materials were made available to the review panel via emails and ftp website. On the morning of Feb 7 before the meeting, the assessment review committee met with Dr. Tom Jagielo and the STAT team to discuss the meeting agenda, reporting requirements, and meeting logistics. During the STAR meeting, all documents were made available electronically.

The draft assessments of Pacific hake were presented by the acoustic survey team and the joint STAT team to the Panel and other attendees, and the input data, models, parameter estimates and biological reference points were evaluated through open discussion. The STAT members were always available when required for further discussion, additional model runs for clarification, and clarification of how the STAR Terms of Reference (ToR) were addressed. A conclusion was then drawn on whether to accept the assessment as a basis for

management of this fishery. The ToRs for this stock were reviewed to ensure they had been fully addressed, and recommendations from the 2009 and 2010 STAR reports and 2009 industry contracted review were reviewed to determine the extent to which they too had been addressed.

3. ROLE OF REVIEWER

I attended the pacific hake STAR review as an independent peer reviewer in accordance with the Statement of Work and ToRs (Appendix 2). I reviewed reports and related documents provided by the STAR meeting coordinator before the review meeting, and reviewed the presentations and report and participated in the discussion on these documents/presentations during the panel review week. This review report is formatted according to my interpretation of the required format and content described in Annex 1 of Appendix 2.

4. CONCLUSIONS AND RECOMMENDATIONS IN ACCORDANCE WITH THE TERMS OF REFERENCES

Below I provide the summary of findings of each ToR in which the weaknesses and strengths are described and conclusions and recommendations in accordance with the ToRs.

ToR 1. Become familiar with the draft Pacific hake/Whiting stock assessment(s) and background materials.

The draft pre-STAR Pacific hake stock assessment report, background documents, and the stock synthesis user manual (version 3.20a) were made available approximately two weeks before the panel review meeting. I spent four (4) days reviewing these documents before the panel review.

ToR 2. Comment on the quality of data used in the assessment(s) including data collection and processing.

Overall, the STAR panel concluded that the data used in the assessment are adequate and appropriate for purpose of the stock assessment. Discussion on the quality of the data was based on past concerns and progress made in 2010. Dr. Stewart summarized progress on data collection and processing made in 2010, including 1) the raw acoustic data were re-analyzed, 2) biomass estimates were based on a method of kriging that was newly developed in 2010 by the acoustic team, 3) uncertainty in the 2009 estimate due to the presence of squid in 2009 was evaluated through a Monte Carlo approach, 4) new sampling failed to reveal a systematic bias in trawl samples, and 5) the analysis results were robust to post stratification. A major difference in using the acoustic data as an abundance index in the 2011 assessment is that the survey data prior to 1995 were not included due to limited spatial and bathymetric coverage. Dr. Stewart's

summary presentation on the data application was further elaborated on by presentations from Dr. Dezhang Chu and Dr. Rebecca Thomas.

One concern arose from the STAR panel, i.e., the temporal variation of the semi-variogram used in the kriging of the geo-spatial fish abundance distribution analysis was diagnosed, but the spatial variation was not. Spatial nonstationarity can be a problem for the hake population (Fuentes, 2001). The acoustic team may explore it in the future. Approaches such as generalized linear/additive models may also be explored as an alternative to developing the abundance index. GLM/GAM may help diagnose the factors that influence the hake distribution and abundance.

Both the acoustic survey team and the STAR panel realized that more work with a larger sample size on the haul representativeness in the acoustic survey in the future will help to validate the haul representativeness.

Dr. Stewart also provided a presentation on the ageing error study based on pooled samples from 2003 to 2009 that had been previously read and ageing error was considered in one of the SS model runs as a sensitivity analysis. Although the hake SS model results were not sensitive to ageing error as demonstrated by the SS team, the study itself is valuable.

Dr. Stewart also demonstrated several data scenarios that the SS team considered which included disaggregated catches and age-composition data by fishery sectors and by seasons. The stock assessment results were not sensitive to this modification of the data structure. Although this work was not used as the base model, the work itself is valuable both from for the hake stock assessment and for its scientific value.

Change of length-at-age relationship over time has been observed and explored. The maturity study was based on samples collected from 1990-1992. The maturity study is suggested to be updated by collecting new samples. Priors of natural mortality and steepness of the SR relationship were discussed and informative priors were used. The currently used informative priors seem narrow, especially those for natural mortality in both models. In general all the biological parameters need to be further explored. Multi-level priors have been found to result in robust parameter estimates (Roberts and Rosenthal 2001; Gelman et al. 2004). Also studies used to estimate natural mortality such as those based on life history information and empirical equations usually only provide the mean estimates of natural mortality.

It has been realized that a tremendous amount of effort has been used to develop the new abundance index based on acoustic surveys and the restructure of the catch data for sensitivity purposes. These efforts were considered quite valuable. In general, the quality of the data used in the hake stock assessment is adequate to provide a suitable basis for exploring

a range of catch-at-age models to provide credible fishery management advice.

ToR 3. Evaluate and comment on analytic methodologies.

This stock was assessed using 2 sets of statistical catch-at-age models/approaches, i.e., TINSS and SS. Both models used the same data and Bayesian estimators were used by both sets of models. Model selection was a major concern before the review, given the draft pre-STAR report. Although the modelling results were still different in biomass, BRPs, and in fishery and population status estimation, the differences were much less after TINSS re-parameterized the selectivity and did not bin the age-composition data.

The SS working group led by Dr. Ian Stewart investigated several new scenarios and studies on 1) disaggregate catch based on fishery sections and seasons, 2) incorporating ageing error, 3) incorporating growth temporal variation, and 4) incorporating temporal variation of selectivity pattern. These investigations were considered very valuable, although they were not used in the final selected benchmark model and were not fully discussed because of the similarity of the results with the preferred base SS model scenario. The extent of agreement of the modelling results with the base scenario was presented and was used as the criterion whether the scenarios/models were worth being considered by the SS team. Future study on model selection and uncertainty evaluation is suggested.

The TINSS working group led by Dr. Robyn Forrest developed a “new” model over the last year. It used a multivariate logistic distribution instead of multinomial distribution (used by SS3 and widely used in fisheries stock assessment) to simulate the distribution of age-composition; it also used a binning approach to deal with the low observation and zero values in age-composition observations (Richards et al. 1997). The advantages of using a multivariate logistic distribution were documented in Richards and Schnute (1998) and in the pre-STAR draft report (JHTWG 2011). One concern that the STAR panel has is that the weighting of the age-composition data is equal, i.e., the sample size is not considered in the current TINSS model. Dr. Steve Martell and Dr. Robyn Forrest would like to explore the possibility of adding the effect of the sample size in the future. The advantages of the binning approach is that zero and low p values in the age/length composition data can be binned to a neighbouring length or age interval, however the binning approach may hide cohort signals also. Dealing with zero values in the catch rate or in the age/length compositions has been a problem. The binning approach provided an extra possible approach that is worth considering in the future. In trial runs, Richards et al. (1997) found that grouping produced much smaller residuals overall than these obtained without grouping. A simulation study on this approach may help evaluate its

value in fisheries stock assessment better. Also a comparison between using multivariate logistic distribution and using multinomial distribution through a simulation study is suggested.

The modelling results from both SS and TINSS are considered convincing and sufficient to provide credible fishery management advice. Because of the time limitation and the confidence of the STAT team in their prior application, no further exploration on their parameterization and prior assumptions were requested or explored. The prior assumptions used should be defended further. A systematic comparison through sensitivity runs on priors and parameterization on selectivity, and recruitment modelling in SS or F_{msy} and MSY in TINSS in the future is suggested. Further exploration of the driving factors to these observed differences and whether these factors should be kept different in their current way was suggested. Uncertainty estimation of the parameters, population size, and biological reference points based on fully developed Bayesian analysis is encouraged to continue. More detailed model equation and description on the symbols used in the equations, the submodels used in different scenarios and the priors used should be provided also.

ToR 4. Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.

Both models, TINSS and SS, do not consider the possible uncertainty in catch. However, both models considered uncertainty in initial population structure, recruitment dynamics, abundance index, and age compositions. Uncertainties of the estimated parameters were provided for the base model runs. However because $F_{40\%}$ was used as the control rule, the uncertainty in the fishery status given the different ABCs were not represented in a probabilistic way.

Maximizing posterior likelihood was used to estimate parameters (MPLE) in many of the sensitivity runs. It would be useful to provide a comparison of the results when MPLE and MCMC are used in solving the same model with the same parameterization and prior assumptions. When both process error and observation or measurement error are considered, parameter estimation is a problem and Bayesian has been recommended as an effective method (Calder et al. 2003; Gustafson 2003; Carroll et al. 2006). In both models, both process error in recruitment and measurement errors in abundance index and in age composition were considered. TINSS used a variance ratio (process error of recruitment/measurement error of abundance index) to deal with this situation which has been used in previous studies. The SS team indicated that a new approach developed by Drs. Methot and Taylor addressed this problem; however, details of the method were not provided.

There are structural differences between the 2 model sets. Some of them are worthwhile to be kept different and to be explored further. The TINSS uses multivariate logistic distribution instead of multinomial distribution to simulate the distribution of age-composition; it also used a binning approach to deal with the low observation and zero values in age-composition observations. It is suggested that the sample size be considered or explored in the multivariate logistic likelihood function in the future TINSS model. Dealing with zero values in the catch rate or in the age/length compositions has been a problem. In trial runs, Richards et al. (1997) found that grouping produced much smaller residuals overall than these obtained without grouping. The binning approach provided an extra possible approach that should be considered in the future. A simulation study on this approach may help evaluate its value in fisheries stock assessment better.

Prior assumptions on natural mortality, steepness in recruitment function in SS or F_{msy} and MSY in the TINSS, and parameterization of initial population structure and selectivity are concerns that I have. As stated in ToR 3, a systematic comparison between less informative and currently used informative priors and between models when the same prior assumptions are used, are suggested through a continuous collaboration of the 2 teams.

ToR 5. Determine whether the science reviewed is considered to be the best scientific information available.

The assessment represents the best scientific information available. The STAR panel considers the Pacific hake stock assessments sufficient to provide the basis for the management of this fishery.

ToR 6. Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modelling approaches and technical issues.

- Because the acoustic survey abundance is the only abundance index used for Pacific hake assessment, conducting the acoustic survey annually seems reasonable if the budget allows. It will help increase the precision of the estimated biomass and fishery/population status.
- Spatial nonstationarity reflected in the semi-variogram over space should be explored in the future to diagnose the hypothesis of stationary semi-variogram, which is currently used in estimating abundance.
- Increase the number of trawls when validating haul representativeness in the integrated acoustic/trawl surveys, since the age-composition from the trawl survey is used as a major source of data to track the cohort signal.

- Conduct a maturity study by collecting new data and do this regularly since growth has been observed to vary over time.
- Explore driving factors (model structure, parameterization, prior assumption) that caused the differences in the output of the TINSS and SS models.
- Further evaluate the value of the structural differences in TINSS and SS models, such as the use of different distribution assumptions on age composition, the way to deal with zero observations in age composition, and the way in parameterizing the initial population structure.
- Explore possible ecological covariates that may be able to refine the recruitment modelling the population's spatial distribution.
- More detailed model equations, uncertainty considered, probability density distributions used, priors used, estimators used, description on the symbols used in the equations, and the submodels used in different scenarios should be provided in equations instead of description only which often causes confusion.
- A comprehensive model selection framework needs to be considered, developed, and used for the future of the joint STAT assessment. Quantitative model selection criteria and model checking criteria should also be considered.

ToR 7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

The Pacific hake stock assessment panel review started at 9AM of Feb 7. The tentative agenda was approved at the beginning of the meeting by all the attendees including STAT, STAR, the acoustic team and the Panel advisors. Dr. Ian Stewart started a presentation on an overview of the acoustic survey data analysis. Dr. Stewart's summary presentation on the data application was further elaborated on by presentations from Dr. Dezhang Chu and Dr. Rebecca Thomas who presented their work on acoustic survey design and data analysis in greater detail. On the afternoon of Feb 7, the STAT team, Drs. Chris Grandin and Ian Stewart, continued their presentations on the fisheries of Pacific hake and the available data sources used and unused in their base model run and in the alternative sensitivity runs.

The open discussions on the acoustic surveys were active and focused on 1) the target-strength relationship, 2) the use of a constant semi-variogram in the same year, 3) the possibility of exploring the driving factors of hake's spatial distribution, age/size composition, and abundance based on the acoustic/trawl integrated surveys, 4) ways to explore the measurement uncertainty of the hake abundance of 2009 when a large number of

Humboldt squid was seen in the survey, and 5) the haul representative study with limited sample size. The discussions were effective and both STAR and STAT understood each other and reached the same conclusion as to what can be improved in data collection and analysis. All the STAR members wrote notes and the chair of the STAR panel compiled the notes and distributed them to both the STAT and STAR.

On the second day, Feb 8, all the input data, models (TINSS and SS), parameter estimates, and fishery status determination were presented by the STAT team, and were evaluated through open discussion. The STAT members were always available when required for further discussion, additional model runs for clarification, and clarification of how the STAR ToRs were addressed. The open discussions on the stock assessment models and results included 1) key differences between the current TINSS and SS base models, and 2) how best to proceed with the review. It was agreed that some of the structural differences between the two models were worth keeping, but some of the parameterization (such as selectivity modeling) and priors may be used consistently, and a systematic study with regard to how the model results are influenced by basic assumptions and inputs should be explored further. The Panel requested that the Joint STAT provide a list of priors, key assumptions, and critical differences in model structures between the TINSS and SS models by the end of the meeting. The joint STAT responded well and provided a table (see Appendix 6). The list of requests throughout the meeting is provided in Appendix 5.

On Wednesday, Feb 9, the joint STAT team presented their responses to the request from STAR and presented/updated further results on the additional model runs. The new TINSS base run resulted in results much closer to those from the SS output. The changes that TINSS made include 1) correction of an error discovered in the age-composition likelihood computation, 2) removal of the age binning structure, 3) estimation of the survey selectivity parameters that were previously fixed, 4) timing of acoustic survey aligned with SS (to middle of year), and 5) weight--at-age in forecast set to the average of the most recent six years (same with SS). There were concerns from the STAR panel on the use of the priors and parameterization used in the base models. Dr. Robyn Forrest agreed to update the TINSS sensitivity runs with the new changes stated above. Also the STAT agreed to update the decision table and the Executive Summary.

On Thursday, Feb 10, the updated sensitivity runs of the TINSS were presented by Dr. Forrest and the STAR team rearranged their results in a systematic way so that comparison between the results of the two models was easier. The STAT also provided their updated Executive Summary. There were some concerns on 1) informative priors, and 2) differences between the two models in modelling age composition, whether and how the age composition data were weighted, how selectivity of the fishery and acoustic trawl survey were modelled, and parameterization of the initial age

structure of the models. The TINSS and SS teams were very confident with the priors used in their base models. Also the time needed to run sets of full Bayesian analyses was not there. So, no further runs were requested or provided.

I consider the review proceedings and discussions effective and I believe that they will improve the stock assessment in the future.

5. SUGGESTIONS FOR IMPROVEMENTS OF NMFS REVIEW PROCESS

The current review process looks very well designed. It can be further improved if a follow-up review can be conducted in the near future. The reason is that a systematic sensitivity analysis will further help our understanding of this stock but full Bayesian analysis is time consuming and seems not appropriate to be required to finish in one to two nights. The STAR review and discussion should be implemented more effectively by this extra follow-up review.

6. Acknowledgements

I would like to thank all the STAT members contributing to the meeting for their informative presentations on the stock assessments of Pacific hake and for providing helpful responses to the review panel's questions. Many thanks also to the scientists at the meeting for their contribution to the discussions throughout the meeting. Special thanks also go to the other members of the review panel for productive discussions on the assessments.

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Appendix 1: List of Documents Provided as Background Material

Cover Letter for the Pacific hake (Whiting) review panel
Tentative Meeting Agenda
List of Participants for the Stock Assessment Review Pacific hake
Pacific Fishery Management Council. 2010. Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012.

Draft Stock Assessment:

Joint US and Canadian Hake Technical Working Group. 2011. Status of the Pacific hake (Whiting) stock in U.S. and Canadian waters in 2011. *Pre-STAR version.*

Background Materials:

Chu, D. 2011. Estimating Pacific Hake *(Merluccius productus*) Biomass Using Geostatistics. National Marine Fisheries Service U.S. Department of Commerce. Northwest Fisheries Science Center, Acoustic Survey Team.
Chu, D. and R. Thomas. 2011. Integrated Acoustic and Trawl Survey: Design, Method, and Analysis. National Marine Fisheries Service U.S. Department of Commerce. Northwest Fisheries Science Center, Acoustic Survey Team.
Martell, S.J.D, W. E. Pine, and C. J. Walters. 2008. Parameterizing age-structured models from a fisheries management perspective. Canadian Journal of Fisheries and Aquatic Science. 65: 1586-1600.
Martell, S.J. 2010. Assessment and Management advice for Pacific hake in U.S. and Canadian waters in 2010.
Pacific Fishery Management Council. 2010. SSC Supplemental Report.
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Pacific Fishery Management Council. 2010. Pacific Whiting the Joint U.S.-Canada STAR Panel Report
Stewart, I.J. and Owen S. Hamel. 2010. Stock Assessment of Pacific Hake, *Merluccius productus*, (a.k.a. Whiting) in U.S. and Canadian Waters in 2010.

Stock Synthesis Model Materials including:

SS Model Changes for PFMC assessments in 2011
Models_SS_Change Log (excel document).
Zip file of SS Models_Simple
Zip file of SS Models_SSv3.20a
SS User Manual_3.20

Appendix 2: Statement of Work for Dr. Yan Jiao

External Independent Peer Review by the Center for Independent Experts

Joint US-Canada Technical Review Panel for the Pacific Whiting Stock Assessment

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Pacific hake (or whiting, *Merluccius productus*) stock assessment will provide the basis for the management of the largest groundfish fisheries off the West Coast of the U.S. and British Columbia. In 2009, Pacific whiting fishery accounted for 79% of the landed catch in the U.S. groundfish fishery. In addition, the treaty between the U.S. and Canada which establishes an annual assessment and management process is expected to be ratified sometime soon. The technical review will take place during a formal, public, multiple-day meeting of fishery stock assessment experts. Participation of external, independent reviewer is an essential part of the review process. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Two CIE reviewers shall have expertise in fish population dynamics, with experience in the integrated analysis modeling approach, using age-and size-structured models, use of MCMC to develop confidence intervals, and use of Generalized Linear Models in stock assessment models. One CIE reviewer shall have expertise in acoustic surveys for fish as they apply to and are used in fishery stock

assessments. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in tentatively in Seattle, Washington during the tentative dates of 7-11 February 2011.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in the Seattle, Washington during the dates of 7-11 February 2011.
3) Tentatively during 7-11 February 2011 in Seattle, Washington as specified herein, and conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 25 February 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and to Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using

the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

4 January 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
24 January 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
7-11 February 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
25 February 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
11 March 2011	CIE submits CIE independent peer review reports to the COTR
18 March 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:

(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

NMFS Project Contact:

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Stacey.Miller@noaa.gov Phone: 206-437-5670

Jim Hastie
National Marine Fisheries Service, 2725 Montlake Blvd. E, Seattle WA 98112
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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Joint US-Canada Technical Review Panel for the Pacific Whiting Stock Assessment

1. Become familiar with the draft Pacific hake/Whiting stock assessment(s) and background materials.
2. Comment on the quality of data used in the assessment(s) including data collection and processing.
3. Evaluate and comment on analytic methodologies.
4. Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.
5. Determine whether the science reviewed is considered to be the best scientific information available.
6. Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.
7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Appendix 3:

Panel Membership or other pertinent information from the panel review meeting

Technical Reviewers
Tom Jagielo, Scientific and Statistical Committee (SSC), Panel Chair
Yan Jiao, Center for Independent Experts (CIE)
Massimiliano (Max) Cardinale, Center for Independent Experts (CIE)
John Wheeler, Center for Independent Experts (CIE)

Panel Advisors
John DeVore, Pacific Fishery Management Council (PFMC) Staff
Dan Waldeck, PFMC Groundfish Advisory Subpanel (GAP)
Rob Jones, PFMC Groundfish Management Team (GMT)
Greg Workman, Department of Fisheries and Oceans (DFO)

Stock Assessment (STAT) Team
Ian Stewart, Owen Hamel, Ian Taylor, and Allan Hicks, National Marine Fisheries Service (NMFS)
Robyn Forrest and Chris Grandin, Department of Fisheries and Oceans (DFO)
Steve Martell, University of British Columbia (UBC)

Pacific hake / Whiting Acoustic Survey Team Presenters
Dezhang Chu and Rebecca Thomas, National Marine Fisheries Service (NMFS)

Appendix 4:

Agenda
Joint US-Canada Technical Review Panel for the
Pacific Hake / Whiting Stock Assessment
February 7-11, 2011
Hotel Decca
4507 Brooklyn Avenue NE
Seattle, WA 98105

Monday, February 7, 2011

9:00 a.m.	Welcome and Introductions
9:15 a.m.	Review and Approve Meeting Agenda (Panel Chair, SSC rep.).
	Review Terms of Reference for Assessments and Review Meeting
	Assignment of reporting duties
10:00 am.	General Overview of the Pacific Hake Acoustic Survey (Ian Stewart and Dezhang Chu, NMFS)
11:00 a.m.	Reprocessing of Historical Acoustic Survey Data and Kriging (Dezhang Chu, NMFS)
12:00 p.m.	Lunch (on your own)
1:00 p.m.	Revisiting the 2009 Pacific Hake Acoustic Survey (Rebecca Thomas, NMFS)
2:00 p.m.	Haul Representativeness in the Pacific Hake Acoustic Survey (Rebecca Thomas, NMFS)
3:30 p.m.	Coffee Break
4:00 p.m.	Overview of the 2010 Hake/Whiting Fisheries o Canadian Waters (Chris Grandin, DFO) o U.S. Waters (Ian Stewart, NMFS)
4:30 p.m.	Overview of the Data Sources for the 2011 Assessment (Ian Stewart, NMFS)
5:30-6:00 p.m.	Adjourn for the day

Tuesday, February 8, 2011

8:00 a.m.	Distribute and review status of notes and draft STAR Report
8:30 a.m.	Overview of the Data Sources for the 2011 Assessment Continued (Ian Stewart, NMFS)
10:00 a.m.	STAT Model Presentations (Ian Stewart, NMFS and Robyn Forrest, DFO)
12:00 p.m.	Lunch On Your Own
1:30 p.m.	STAT Model Presentations Continued
	Q&A session with the STATs
4:30 pm	Panel develops list of model runs / analyses for the STAT(s).
5:30-6:00 p.m.	Adjourn for day.

Agenda

Joint US-Canada Technical Review Panel for the
Pacific Hake / Whiting Stock Assessment
February 7-11, 2011
Hotel Decca
4507 Brooklyn Avenue NE
Seattle, WA 98105

Wednesday, February 9, 2011

8:00 a.m. Distribute and review status of notes and draft STAR Report

8:30 a.m. STAT presentation(s) of requested model runs/analyses.

11:00 a.m. Panel Discussion

12:00 p.m. Lunch On Your Own.

1:30 p.m. Panel develops second list of model runs / analyses for the STAT team(s).

5:30-6:00 p.m. Adjourn for day.

Thursday, February 10, 2011

8:00 a.m. Distribute and review status of notes and draft STAR Report

8:30 a.m. STAT presentation(s) of second set of requested model runs/analyses.

12:00 p.m. Lunch (On Your Own).

1:30 p.m. Panel discussion.

- Identification of base model and elements for the decision table.
- Panel develops third list of model runs for decision table and begins drafting STAR report.

5:30-6:00 p.m. Adjourn for day.

Friday, February 11, 2011

8:00 a.m. Distribute and review status of notes and draft STAR Report

8:15 a.m. STAT presentation(s) of third set of requested model runs/analyses.

10:00 a.m. Panel discussion.

- Discuss MCMC runs for base case model and decision table

11:00 a.m. Panel finalizes STAR report

12:00 p.m. Panel Adjourns.

Appendix 5: list of requests from STAR panel and the joint STAT responses.

February 8, 2011

Request No. 1:
The Panel requested that the Joint STAT provide a list of priors, key assumptions, and critical differences in model structures between the TINSS and SS models.
Rationale: This will guide the decision for formulating alternative model runs and sensitivity requests for the Joint STAT.
Joint STAT Response: A detailed table was provided (see Appendix I).

Request No. 2:
Change the survey and fishery age composition binning in TINSS to try to resolve "problem" year class estimations (such as 2007). Also look at selectivity and catchability. Plot selectivities against SS values for direct comparison of the two models.
Rationale: Basic housekeeping.
Joint STAT Response: The binning structure was removed from TINSS and characterization of the problematic year classes was much improved. A plot was also prepared comparing selectivity estimates from the two models. Closer agreement in survey and fishery selectivity was evident, with the TINSS curves to the right of the SS estimates of selectivity at age.

Request No. 3:
Standardize the weight-at-age assumption in the stock forecast and estimation of MSY for both models.
Rationale: Basic housekeeping.
Joint STAT Response: This was done in stock forecast but not in estimation of MSY due to fundamental differences in the SS and TINSS model parameterizations.

Request No. 4:
Standardize the treatment of survey timing for both models.
Rationale: Basic housekeeping.
Joint STAT Response: Done.

Request No. 5:
Look at what model components affect differences in B_0 between models, i.e., produce numbers at age (at B_0) for the two models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: Done. The vectors were similar and differed mainly in scale. It was noted that looking at the 1966 vectors may provide additional insight into differences between the models.

Request No. 6:

Decide if ageing error and selectivity should be handled the same way in both models. If so, standardize for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: The Joint STAT reported that some differences exist in this area with regard to modeling philosophy. There was not time to fully evaluate the differences during this meeting.

Request No. 7:
Decide if model age composition weights should be handled the same way for both models. If so, standardize for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: There was not enough time to do this at this meeting. Further exploration of age composition likelihood functions should form a research recommendation.

Request No. 8:
Examine sensitivity to selection of maturity schedules for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: The Joint STAT found that it was not easy to align these at this time, and noted that this should be revisited when the maturity data are updated. Updating the maturity schedules should form a research recommendation.

February 9, 2011

Request No. 9:
Update the set of sensitivity runs for TINSS. Provide tables and figures for the Panel to review.
Rationale: The TINSS model has changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by Dr. Forrest and will be included in the final stock assessment document.

Request No. 10:
Update the decision tables. Provide tables for the Panel to review.
Rationale: The TINSS model has changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by the Joint STAT and will be included in the final stock assessment document.

Request No. 11:
Update the stock assessment document Executive Summary section and distribute.
Rationale: The results have changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by the Joint STAT and will be included in the final stock assessment document.

Appendix 6: A summary table of the differences between the TINSS and SS, response from the joint STAT team.

	TINSS	SS	STAT category
Data use			
Likelihood for age-composition data	Multivariate logistic	Multinomial (0.001 added to obs. and exp.)	1
Weighting of composition likelihood	Automatic	Iterative	0
Weighting heterogeneity among years for compositional data	Uniform	Reflects sample size	1
Additional variance component for acoustic survey index	Variance, multiplicative	log-SE, additive	0
Aggregation of small age-frequencies	<=1.5%	None	1
Fit to age 1 in fishery age compositions	No	Yes	0
Maturity	Logistic by age	Age from logistic by length x growth	0
Priors			
Steepness (h)	NA	Informative Beta	1
FMSY	Informative log-Normal	NA	1
MSY	Informative log-Normal	NA	1
Acoustic catchability (q)	Informative log-Normal	Analytical solution	1
Total precision (observation error and recruitment variability)	Informative Gamma	NA	1
Ratio of observation error to recruitment variability	Informative Beta	NA	1
Sigma R	Function of variance ratio and precision	Iterated	1
Dynamics			
Leading parameters estimated	MSY, FMSY	Steepness, log-R0	0
Ageing error	None	Base plus cohort	0
Age-based fishery selectivity	Logistic (estimated)	Non-parametric (non informative priors to age 5)	1
Age-based survey selectivity	Logistic fixed	Non-parametric (non informative priors to age 5)	1
Catch removal	Baranov catch equation	Pope's approximation	0
Timing of acoustic survey	Beginning of year	Middle of year	0
Weight-at-age for forecast	Terminal year	Average of most recent 6 years	0
Weight-at-age for *MSY*	Average over time series	Average of most recent 6 years	0